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David K. Aylward

ORIGINAL

August 8, 1997

William F. Caton
Acting Secretary
Federal Communications Commission
Room 200
1919 M Street, N.W.
Washington, DC 20554

Re: Notice of Ex Parte Communication
CC Docket Number 94-102

Dear Mr. Caton:

On August 7, 1997 representatives of TruePosition, Inc., a subsidiary of The Associated Group, Inc. met with David Siddall, Legal Advisor to the Honorable Commissioner Susan Ness. David Berkman of The Associated Group, Kent Sander of TruePosition, and myself attended this meeting.

The purpose of the briefing was to discuss further the results of the successful Phase II E9-1-1 trial sponsored by TruePosition and the State of New Jersey and the implications the results have for the Report and Order and Further Notice of Proposed Rulemaking. A copy of the report that was distributed at the meeting and released by the New Jersey Attorney General, *The First 100 Days*, is attached for the record. In compliance with section 1.1206 of the Commission's rules, we have submitted two copies of this document for the record.

If you have any questions regarding this letter or attached materials, please contact me at your convenience.

Sincerely Yours,

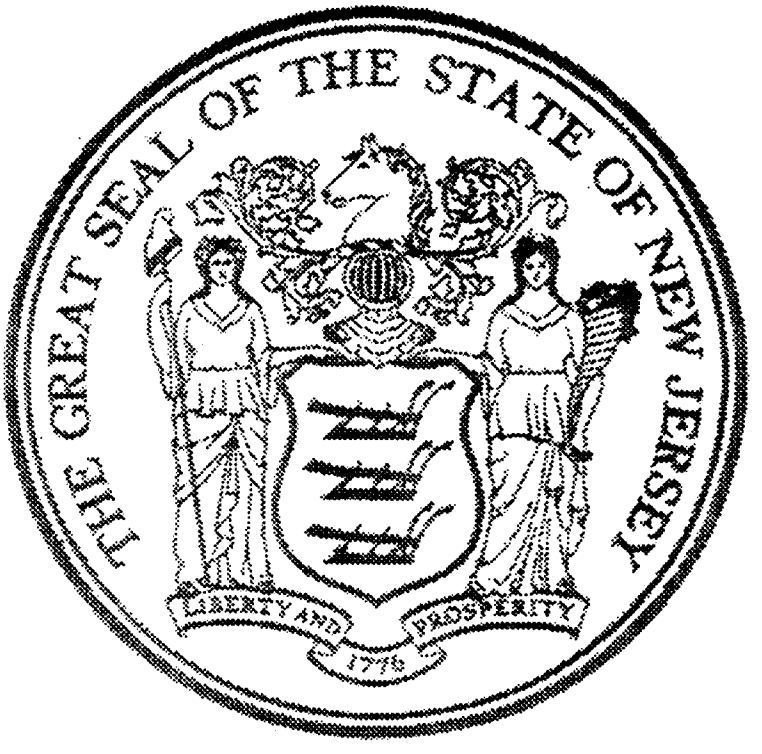
David K. Aylward

David K. Aylward

CC: David Siddall

Report On The New Jersey Wireless Enhanced 9-1-1 System Trial January 22 to April 30, 1997

The First 100 Days



State of New Jersey
Department of Law and Public Safety
Division of State Police
Colonel Carl A. Williams, Superintendent
Office of Emergency Telecommunications Services
S. Robert Miller, Executive Director

Christine Todd Whitman
Governor

Peter Verniero
Attorney General

June 16, 1997

State of New Jersey
DEPARTMENT OF LAW AND PUBLIC SAFETY
OFFICE OF THE ATTORNEY GENERAL
CN 080
TRENTON, NJ 08625-0080
(609) 292-4925

CHRISTINE TODD WHITMAN
Governor

PETER VERNIERO
Attorney General

June 16, 1997

I am pleased to release the report entitled "The First 100 Days", detailing the results of New Jersey's first in-the-nation live trial of Wireless Enhanced 9-1-1 technology. This trial had an immediate impact on improving public safety. The findings from the trial represent significant progress in our efforts to quickly locate emergencies after a wireless caller dials 9-1-1. They prove that the commercial technology exists and can be deployed to meet the Federal Communications Commission's Wireless E9-1-1 Report and Order in Docket No. 94-102.

The State of New Jersey took the lead in conducting the nation's first live trial utilizing wireless location technology. The cooperation between the State of New Jersey, county governments, emergency personnel, and the private sector demonstrated a partnership model that can be replicated to provide enhanced wireless 9-1-1 service across the State and throughout the country.

Over an area of 350 square miles in southern New Jersey, where the location technology was deployed, our Public Safety Answering Points (PSAPs) were quickly able to pinpoint the location of over 3,500 wireless callers. Dispatchers had to stay on the phones for far less time with each individual caller, and even callers with no recognizable landmarks in sight were easily and quickly located. This meant that multiple dispatch units did not need to be sent to callers who could not describe their location, and accidents which received many calls from passing motorists could be easily identified as one incident. Most important, response units were able to arrive at emergency scenes much more quickly to aid victims. Overall, this new system was extremely efficient in helping 9-1-1 callers.

We hope that the findings and recommendations in this report will help expedite the full and rapid deployment of wireless E9-1-1 location technology. With more than 46 million wireless subscribers in the U.S. and 60,000 wireless calls to 9-1-1 being made each day, and both increasing rapidly, the need for a nationwide wireless 9-1-1 location system grows every day.

Sincerely yours,

Peter Verniero

Peter Verniero
Attorney General

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Mission Statement of the New Jersey Office of Emergency Telecommunications Services (OETS)

The New Jersey Office of Emergency Telecommunications Services (OETS), in consultation with the telephone companies and the Board of Public Utilities and with the assistance of the Office of Telecommunications and Information Systems in the Department of Treasury, has the responsibility to plan, design, coordinate and implement the statewide 9-1-1 (enhanced) telephone system.

Executive Summary

Background Wireless calls to E9-1-1 Public Safety Answering Points (PSAPs) have significantly improved public safety. However, because of call volume and the time it can take for emergency personnel to determine the location of the caller, they have created new challenges. Unlike wireline calls to E9-1-1, there is no information, such as a callback number or the caller's location, available to E9-1-1 operators for answering wireless calls. Frequently, wireless callers do not know their exact location, especially at night when surroundings are unfamiliar and the trauma of an accident or other emergency reduces cognizance. Therefore, in July, 1996, the FCC issued a Report and Order designed to address these problems. FCC Phase I provides for callback number and originating cell site to be reported to E9-1-1 operators. Phase II provides for the callback number and the caller's location (generally within 410 feet).

Launch On January 22, 1997, only 6 months after the FCC Report and Order, the New Jersey Office of Emergency Telecommunications Services (OETS) launched the first live wireless enhanced 9-1-1 trial in the United States. The trial, using the Comcast Cellular Communications system, covered a 50 mile corridor of the New Jersey Turnpike and I-295 through Salem, Gloucester, Camden, and Burlington counties, and employed new and developing technology from a number of companies including: TruePosition, SCC Communications, Rockwell Telecommunications, KML Technologies, and others. The trial focused on the most popular type of wireless telephone in the country - cellular AMPS-based telephones.

Objectives The primary objective of the New Jersey Wireless Enhanced 9-1-1 System trial was to determine whether commercial technology exists today to meet New Jersey's wireless 9-1-1 requirements and those of the FCC Report and Order. Since the technology was literally brand-new and developing, OETS also wanted to determine (i) whether changes would be required to move from technology trial to full operational systems, (ii) what technical system integration challenges must be faced, (iii) whether the trial would have any impact on the existing New Jersey 9-1-1 network, and (iv) whether E9-1-1 operators would see significant value in having technology like this at their disposal.

Results Based on testing conducted from January 22 to April 30, 1997, OETS has concluded that the system trial was extremely successful in demonstrating that commercial technology exists to meet the needs of the FCC's Phase I and Phase II in New Jersey and elsewhere. This conclusion is based upon over 3,500 live wireless 9-1-1 calls received, and over 81,000 test calls placed by participants in the trial. The wireless 9-1-1 location system was demonstrated on multiple days at multiple test points on calls by multiple independent test participants and proves its ability to meet the FCC Phase II requirement of 410 feet, 67% criteria. OETS also concluded the system was extremely valuable to E9-1-1 operators, and that the impact on the existing network was minimal. Most importantly, OETS concluded that its everyday use made emergency response so routine that sensational 'search and rescues' like that involving a woman stuck in the snow for 40 hours in South Dakota never happened. The testing also identified changes required when upgrading from technology trial to full state-wide operations. For example, test points achieving the 410 feet requirement were in areas of good location system coverage. The overall system average was approximately 600 feet, but this can be lowered to or below 410 feet by upgrading the system coverage to the level used in the successful areas.

I. Wireless E9-1-1 Background

A. Increasing Usage of Wireless Expands the Need for Enhanced 9-1-1

The first cellular system in the country was turned on in 1983. Today, there are over 46 million wireless subscribers (approximately 96% using cellular AMPS-based telephones) -- representing almost 20% of the U.S. population. With so many persons carrying wireless telephones, emergency calls from wireless devices to 9-1-1 have dramatically increased. In 1994, the number of wireless calls per day to 9-1-1 totaled 50,000 nationwide. Last year, the growth of daily emergency wireless calls had reached an estimated 60,000 nationwide. By the turn of the century, this number is expected to top 130,000 calls per day (approaching the number of 9-1-1 calls initiated from wireline networks). Wireless telephones are increasingly used as essential tools in the effort to ensure the broader community's safety, not just for individuals concerned about being able to communicate in emergencies. For example, local crime watch groups across the country, such as Communities on Phone Patrol (COPP) or those in Camden County, use wireless phones to dial 9-1-1 to report incidents and request assistance from local police and rescue units.

As more telecommunications carriers enter New Jersey markets to provide new types of wireless services, lower prices and more competition will mean more usage of wireless phones and, subsequently, more wireless calls to 9-1-1. Wireless 9-1-1 calls represented 43% of all calls to 9-1-1 received at the test area PSAPs during the trial. Across the state, wireless represents a growing proportion of all emergency calls as well.

The growth in wireless use has made a significant contribution to public safety, providing notice of accidents, crimes, and other emergencies more quickly than if only wireline telephones could be used. But because of this increase in wireless 9-1-1 calls, PSAPs throughout New Jersey report an increasing number of challenges that impede their ability to assist people in emergencies. The benefits of E-9-1-1 is lost when PSAPs cannot find these callers.

Wireless calls to E9-1-1 PSAPs have created a new challenge for these operations, both in volume and in the time it takes emergency personnel to respond. Unlike landline calls to E9-1-1, there is no information, such as a callback number or the caller's location, available for wireless calls to E9-1-1 operators. Frequently, wireless callers do not know their exact location, especially at night when surroundings are unfamiliar and the trauma of an accident or other emergency reduces cognizance. Therefore, dispatchers must typically stay on the call longer, attempting to determine the location. When the location cannot be determined, multiple response units must be dispatched to find the caller. It is also common for four to five motorists to call '9-1-1' to report a single accident, all attempting to describe the same location. If the location descriptions are not consistent, dispatchers cannot discern whether there is really just one accident or multiple accidents and may have to play it safe by dispatching multiple units.

Across the country, there have been well publicized incidents in which prompt identification and location of a wireless E9-1-1 caller would have greatly improved response time and increased the chances for reducing injury and saving lives. For example, during a South Dakota blizzard in January, 1997 Karen Nelson of Webster, SD was trapped in her car beneath a snow drift in sub-zero degree temperatures. Her cellular phone saved her life, but it took police and rescue teams over 40 hours to locate her because there was no location technology in place. While some have been more publicized than others, these incidents which happen every week, can be reduced through deployment of wireless location technology.

The typical time a dispatcher spends confirming the location of an enhanced 9-1-1 wireline call is 5-10 seconds. With these calls, the address and call-back number of the calling party is displayed directly in front of the dispatcher, who merely has to confirm the information on wireless calls. Without the new location technology, PSAP dispatchers regularly spend from 30-45 seconds to several minutes on each wireless call. At night, time spent on calls without automatic location technology increases dramatically. One PSAP director in the trial area said, "without location technology, the dispatcher would have to spend time trying to pull-out landmarks from the caller and then in some cases take their best guess."

Without wireless E9-1-1 location technology in place, these factors add up to rising costs for PSAPs and ultimately higher taxes for consumers. Increased wireless use will mean increased 9-1-1 calls from wireless phones. Wireless calls take much longer to process, require greater levels of expertise, and result in much more duplication than wireline emergency calls. If this trend continues, there will have to be larger PSAP facilities, additional trunk lines, more switches, and probably twice as many call-takers. And they will still not know the location of wireless callers.

B. FCC Ruling

The wireless industry, the E9-1-1 community, and the Federal Communications Commission (FCC) began joint efforts in mid-1994 to solve the technological and policy hurdles to providing wireless E9-1-1. In June 1996, the FCC issued a Report and Order in Docket 94-102, formalizing the requirements and implementing a schedule for wireless E9-1-1 emergency calling systems. In so doing, the FCC ordered that implementation and deployment of wireless E9-1-1 features and functions be accomplished in two phases:

Phase I (to be completed by April 1, 1998)

Wireless carriers must report the callback number (also known as Automatic Number Identification or ANI) and originating cell site and/or sector of a 9-1-1 call to requesting 9-1-1 PSAPs.

Phase II (to be completed by October 1, 2001)

Wireless carriers must report the location of all 9-1-1 callers (known as Automatic Location Identification or ALI) with an accuracy of 125 meters (410 feet) for 67% of the callers to requesting 9-1-1 PSAPs.

II. Background of Trial

A. New Jersey's First in the Nation Live Wireless E9-1-1 Field Test

Realizing the importance and need for wireless E9-1-1, New Jersey became the first state in the nation to conduct a live trial of wireless E9-1-1 with location technology. On January 22, 1997 the first wireless E9-1-1 system trial was launched in New Jersey using the Comcast Cellular Communications System and the TruePosition Wireless Location System. The Attorney General of the State of New Jersey, the Chairman of the Federal Communications Commission, and the President of the Cellular Telecommunications Industry Association assisted in the launch. The test included a variety of active test participants, including the New Jersey Attorney General's Office, New Jersey State Police, OETS, and E9-1-1 coordinators from Camden, Gloucester and Salem Counties. The key role of Selective Routing (SR) was provided by Bell Atlantic, Rockwell, and SCC. KML, On-Target Mapping, MapInfo, and QED were responsible for the PSAP terminals and the mapping displays.

Prior to the New Jersey trial, no location system had ever been deployed for wireless telephones over such a large area. The TruePosition Time Difference Of Arrival (TDOA) location system OETS tested had previously been successfully tested in smaller areas of 20 square miles or less, including downtown Philadelphia, Baltimore, and Houston. But additional techniques and functionality were to be attempted to scale the location system from 20 square miles to 350 square miles.

The system was tested from January 22 to April 30, 1997 and located wireless E9-1-1 callers on the southern 50 miles of the New Jersey Turnpike/Interstate 295 corridor, an area of approximately 350 square miles. The TruePosition Wireless Location System was deployed on 24 cellular towers of the Comcast Cellular Communications System and covered portions of four counties: Salem County at the southern end, then Gloucester County, Camden County, and Burlington County on the northern end. The location system as deployed is shown in the picture below:

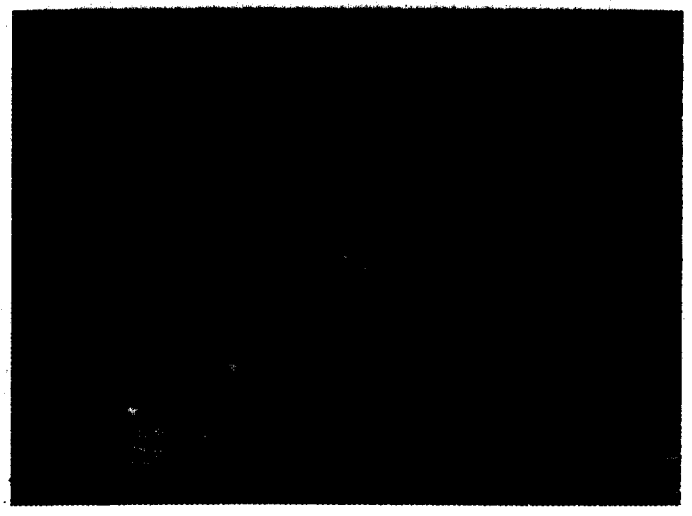

Figure 1 – Location System Coverage – Receiver and PSAP Coverage

Trial Objectives

The objectives of the New Jersey Wireless Enhanced 9-1-1 System trial were to:

- Implement the first operational wide-area commercial location trial using technology from many participants as a first step in reaching Phase II of the FCC's Report and Order.
- Accurately measure the performance of a TDOA wireless location system and determine its ability to locate wireless E9-1-1callers, including the number of receivers required.
- Based on actual field use, identify any system improvements needed before planning for full state-wide operational systems.
- Determine the technical system integration required between the many participants in the trial.
- Determine the impact that a wireless enhanced 9-1-1 system would have on the existing 9-1-1 communications network.

- o Determine the impact of the wireless E9-1-1 system on PSAP operations.

- o Collect anecdotal and statistical evidence useful in determining the value of wireless E9-1-1 systems to callers in actual emergencies.

B. Trial Participants

There was a broad range of support and cooperation between private industry and State of New Jersey public agencies. Listed below are the participants of the trial:

Government Agencies
Department of Law and Public Safety
Division of State Police
Office of Emergency Telecommunications Services (OETS)
Camden County Department of Public Safety
Gloucester County Department of Public Safety
Salem County Department of Public Safety

Companies	Product and/or Service Provided
The Associated Group/TruePosition, Inc.	TruePosition Wireless Location System
Comcast Cellular Communications	Cellular Network
Bell Atlantic - New Jersey	9-1-1 network communications
SCC Communications	9-1-1 selective routing
Rockwell Telecommunications	9-1-1 tandem switch
KML Technologies	PSAP terminals
MapInfo	Electronic mapping programs
On-Target Mapping	Electronic map data
QED	Electronic map data

III. Technology -- How it Works

A. Location Technology - TruePosition System

There are over 25,000 cell sites in the U.S. today, but wireless communications networks are designed so that a mobile telephone uses only one cell site at a time. These systems are very efficient for placing calls, but current receivers are not capable of determining an emergency caller's exact location.

The TruePosition Wireless Location System relies on advanced location receivers added to existing cell sites. The signals transmitted by a cellular phone during a 9-1-1 call are collected by the TruePosition receivers at three to eight different cell sites. The TDOA technology used by TruePosition is the same technology used in the Global Positioning System (GPS) and in many radar systems. TDOA relies on a precise timing of the signals sent by a mobile phone during the start of a 9-1-1 call. The signals travel at the speed of light in many directions from a telephone. TruePosition measures the difference in times the signals reach different receivers, using techniques accurate to billionths of a second. The data collected by these receivers are then combined in a central processing system to calculate an emergency caller's location. Typically, the location is displayed on an emergency dispatcher's computer map terminal before the call is even answered.

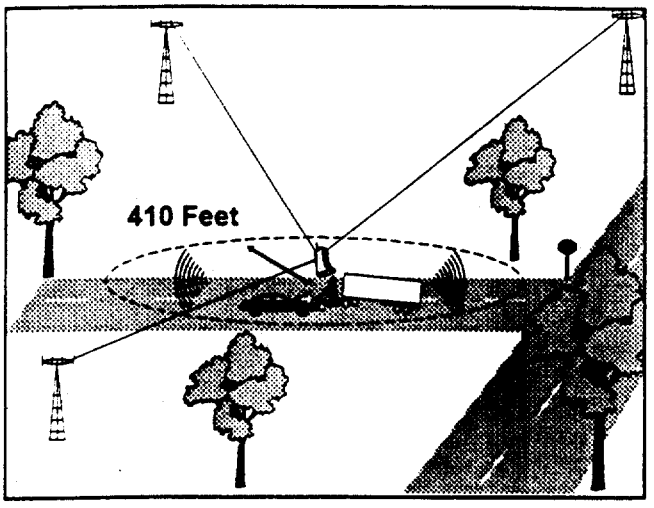

Figure 2 - Location Technology At Work

The use of TDOA technology at cell sites means that no wireless telephone will need to be changed, including the 46 million wireless telephones in use today in the U.S. Technology upgrades are needed only at cell sites, and users of wireless networks can keep the mobile telephones they already own and still obtain the benefits of E9-1-1.

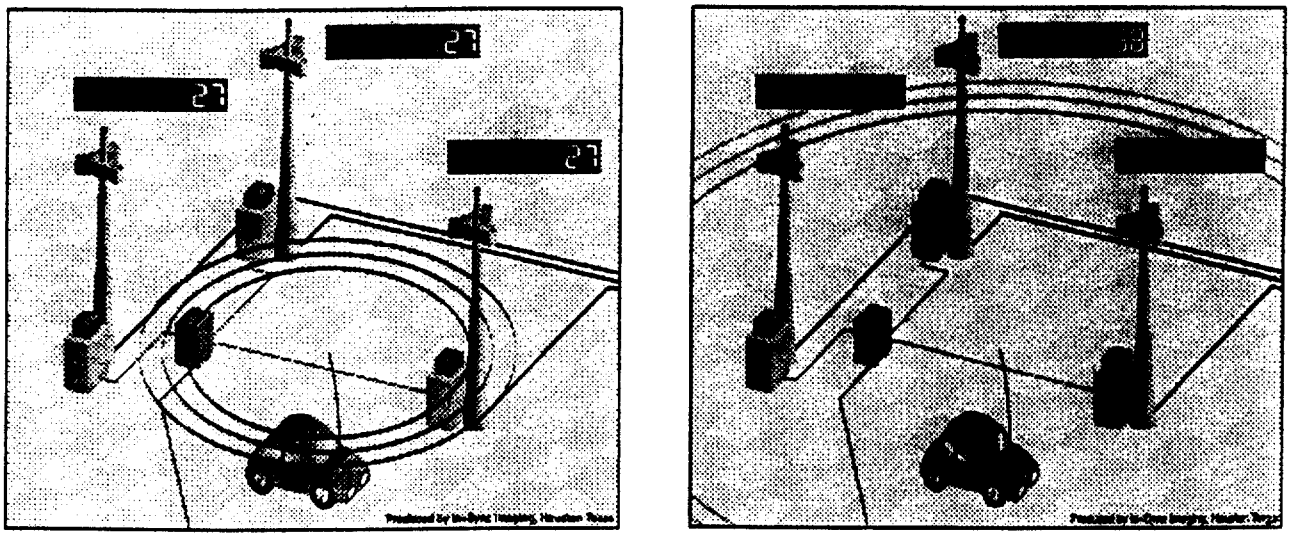

Figure 3 – Model of Time Difference Of Arrival Location System

B. E9-1-1 Call Routing Technology

Enhanced wireline 9-1-1 systems today provide a unique feature called Selective Routing. This feature allows 9-1-1 calls to be delivered to the correct PSAP based upon the location from which the call originated. Call routing for each individual telephone number is pre-determined based on address/location information supplied by the local exchange carrier and the emergency response agencies. Call routing and address/location information is updated to databases that are then available for live 9-1-1 call processing. All initial database

creation and ongoing maintenance is performed administratively in background modes. A significant challenge to implementation of a Phase II wireless E9-1-1 solution is the application of coordinate based location information to the proper routing of a 9-1-1 call.

In a wireless network, it is not possible to pre-determine the source location of a 9-1-1 call because the communication devices are always moving. For this reason, the traditional Master Street Address Guide (MSAG) and pre-processed relational files cannot be used. A geofile or map base must become the backdrop for routing decisions. As a coordinate pair is received from the location system, it is electronically plotted against the geofile to determine its relationship to PSAP boundaries. Routing instructions are dynamically created in real time and provided to the E9-1-1 network during the call set up process. The coordinate data is then used dynamically to create an ALI record for distribution to the appropriate 9-1-1 call taker.

Selective Routing technology for the New Jersey Wireless Enhanced 9-1-1 System trial was jointly provided by Bell Atlantic, Rockwell Telecommunications, and SCC Communications Corporation.

SCC provided their SR/ALI platform, with their Dynamic Call Routing (DCR) feature. The DCR application uses a "Point in Polygon (PiP)" routine for dynamically calculating the Emergency Service Number (ESN), which is used to provide routing instructions to the Rockwell E9-1-1 tandem switch. The creation of a dynamic ESN is the result of matching the X,Y coordinate location of a calling party with an ESN polygon layer in the PiP routine of the DCR application. This information is then provided to the SR/ALI platform where network call routing instructions and ALI records are dynamically created.

Bell Atlantic's E9-1-1 tandem switch, supplied by Rockwell, has the advanced capability of querying an external system for routing instructions. Using this real time interface, the Rockwell SCX queries the SR/ALI system for 9-1-1 call routing instructions and receives the ESN information that was dynamically created using the wireless caller's location data.

This process allows wireless 9-1-1 calls to be delivered to the correct PSAP with location information to support an appropriate emergency response.

C. An Integrated Wireless Enhanced 9-1-1 System Design

When a person makes a wireless emergency call, information is simultaneously sent through two routes to complete both phases of an E9-1-1 call. The caller's voice, 10-digit wireless phone number (Automatic Number Identification) and information about the nearest cell site (Pseudo-Automatic Number Identification) initiating the call are routed through Comcast Cellular's base station (BS in the following diagram) and Mobile Switch Center (MSC). This information is then passed by Comcast to the Local Exchange Carrier (LEC), which in this case is Bell Atlantic-New Jersey. Bell Atlantic routes the information to the Rockwell 9-1-1 tandem (9-1-1 in the diagram).

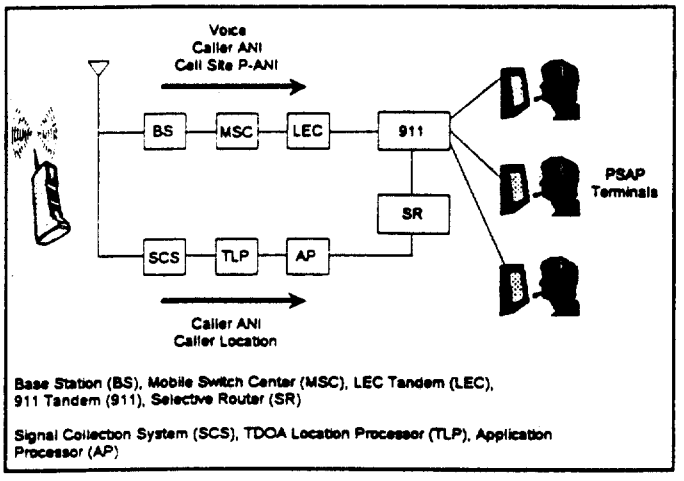

Figure 4 – Wireless Enhanced 9-1-1 System Network Design

The 9-1-1 tandem then queries the SCC SR/ALI for the proper PSAP to contact, based on location information developed as follows.

At the same time as the above call process is proceeding, the call is also processed through TruePosition's Signal Collection System (SCS) receivers on multiple Comcast cell sites. Each of the SCS's passes timing information to the TDOA Location Processor (TLP), which calculates the caller's location based on the different signal arrival times at the various receivers. TruePosition's Application Processor (AP) then passes on this information to SCC Communications SR/ALI system (SR). The SR/ALI system dynamically determines the correct PSAP destination for the wireless E9-1-1 caller, and then passes the call routing information to Rockwell's 9-1-1 tandem switch. Both sets of information, including the caller's number and the caller's location, are then transmitted to the correct PSAP and displayed on the graphical PSAP terminal (supplied by KML Technologies).

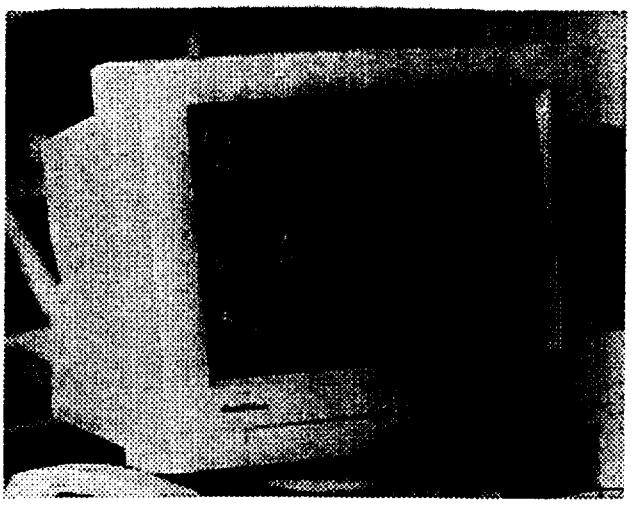

Figure 5 – Picture of E9-1-1 PSAP Terminal Showing Map

Each diamond on the diagram represents a single location estimate for a single 9-1-1 call from a subscriber using the Comcast Cellular network. Because there were so many location estimates performed by the system, some of the map appears completely filled. Therefore, the following statistics are useful to understanding the profiles of these wireless E9-1-1 callers.

2. Specific Locations of Callers

The locations of the wireless E9-1-1 callers were analyzed to determine where emergencies occur. The 3,505 wireless E9-1-1 calls were grouped into four categories:

1,833 (52%) of emergency calls came from interstate highways, such as the New Jersey Turnpike, the Pennsylvania Turnpike Extension into NJ, and I-295.

896 (26%) of emergency calls came from other 4 lane roads and highways that did not have interstate designation, such as Routes 42, 55, 70, 73, 38, 41, and 30. Anecdotal evidence suggests that some of these 4-lane highways may have represented an even greater percentage of emergencies if the coverage area of the trial system had been extended. For example, the portions Routes 42 and 55 within the coverage area exhibited heavy call volume, and PSAP dispatchers indicated that the same call volume also extends outside of the coverage area.

424 (12%) of emergency calls came from major state and county 2 lane roads, such as Springdale Road, Greentree Road, Evesham Road, Route 541, and many others. These are connector roads typically used for commuting and for access to the 4 lane highways.

352 (10%) of emergency calls came from other places, such as residential streets, parking lots, and near or inside buildings.

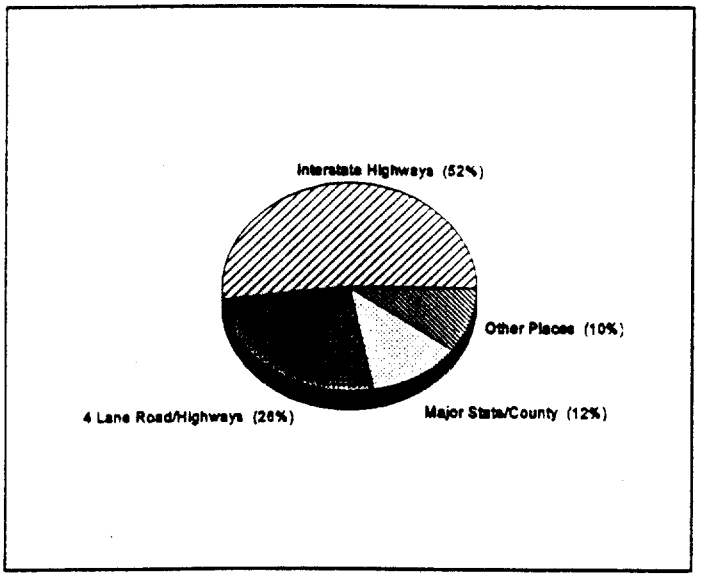

Figure 8 – Specific Location of Wireless 9-1-1 Callers

The KML PSAP terminal provides each dispatcher with a toggle switch key to display the text version of a caller's information (phone number and location) and/or graphical mapping information with the caller's location prominently displayed. MapInfo provided electronic mapping programs for the trial and On-Target Mapping and QED provided electronic map data.

IV. Trial Results

A. Emergency Calls to PSAPs

1. Total Calls Located

The TruePosition location system provided location reports for 3,505 actual wireless E9-1-1 callers from January 22 to April 30, 1997. This includes both local customers and visitors traveling from another area. Over the entire period, an average of 35 wireless E9-1-1 callers per day were located, but the actual number of calls per day and per week varied based upon weather and other factors. On the bar graph below, the number of wireless E9-1-1 callers located during each week of the trial is shown along the vertical axis, and the data on the horizontal axis represents a 7-day period beginning on the date shown, except for the first and last weeks, which were shorter in length.

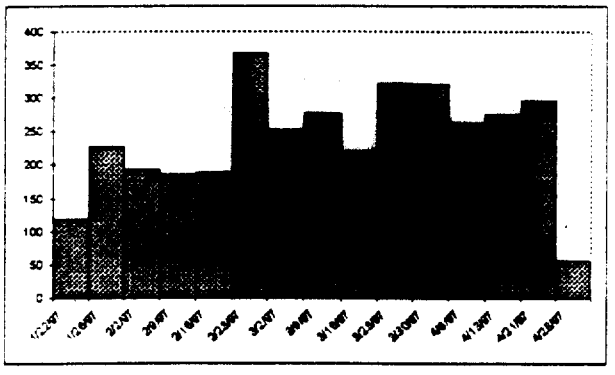

Figure 6 – Number of Located Wireless 9-1-1 Calls per Week

A plot of all wireless E9-1-1 callers located by the location system is shown below:

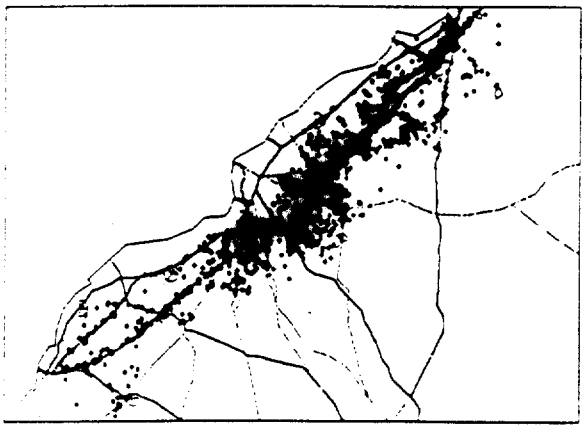

Figure 7 – Plot of All Wireless 9-1-1 Calls Located by TruePosition

3. Area Codes of Roaming Callers

The TruePosition system was installed on Comcast Cellular Communications cell sites, and was capable of locating any wireless caller compatible with the Comcast system. Many callers were not local, especially on the New Jersey Turnpike. For example, during one accident that occurred during the trial, five calls were received in rapid succession at the Gloucester County PSAP. Based upon the area codes of the five phones used to make the wireless E9-1-1 calls, none of the callers were from New Jersey, southeastern Pennsylvania, or Delaware. The 3,505 E9-1-1 calls were analyzed to determine the ratio of local and non-local callers:

2,464 (70%) of the emergency callers were from southern and central New Jersey (phone numbers beginning with area codes 609 and 908).

103 (3%) of the emergency callers were from northern New Jersey (area code 201).

521 (15%) of the emergency callers were from Pennsylvania (area codes 215 and 610)

44 (1%) of the emergency callers were from Delaware (area code 302).

373 (11%) of the emergency callers were from other area codes.

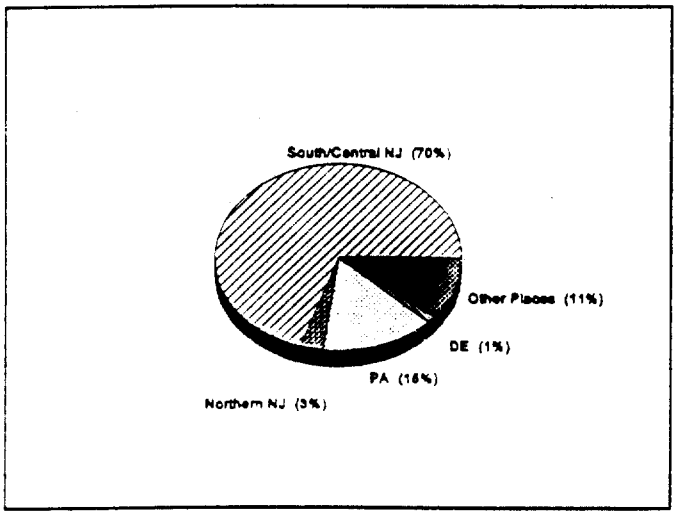

Figure 9 – Area Codes of Roaming Callers

Thus, 30% of the wireless E9-1-1 callers were not local. There was not sufficient anecdotal data collected to determine whether callers from "out of town" were less familiar with their surroundings, and perhaps more likely to require the assistance of location technology to determine their exact location.

In addition to the 3,505 wireless E9-1-1 callers located by the Phase II location system, an additional 1,697 wireless E9-1-1 callers were served by the Phase I (number identification) portion of the trial system. These callers were not within the coverage area of the TruePosition system, and so could not be located. Even though the callers were outside of the location coverage area, the caller's callback information (ANI) and the cell site could be determined from the Phase I ANI/pseudo-ANI reporting from the cell sites involved in the trial area.

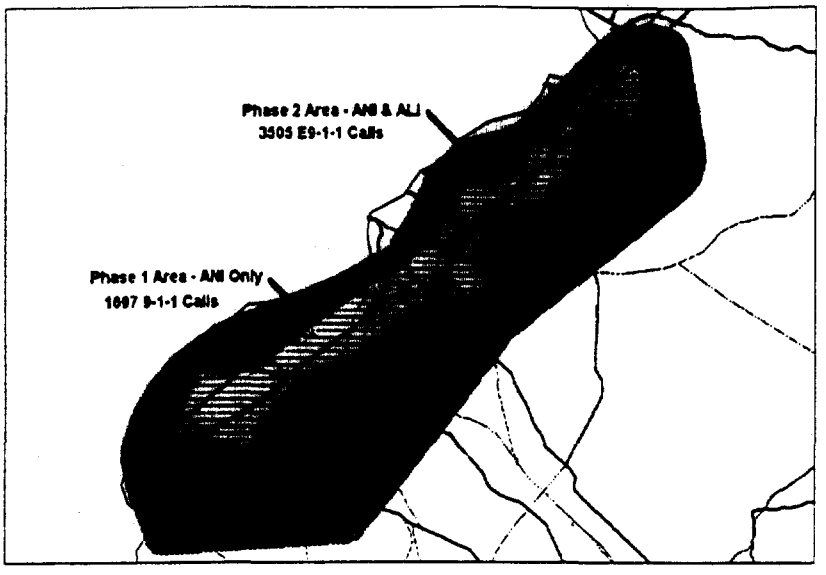

Figure 10 - Phase I/Phase II Area

The trial system was configured so that wireless E9-1-1 callers that were located in the Phase II coverage area of the system were routed to the appropriate PSAP based upon the 9-1-1 caller's calculated location. In all 3,505 cases, the call was routed to the correct PSAP. In contrast, wireless E9-1-1 callers served by the Phase I portion of the trial system were routed to the PSAP closest to the cell site at which the 9-1-1 call originated. These callers were routed to an inappropriate PSAP approximately 30% of the time. This occurred because cell site radio coverage frequently overlaps the geographic boundaries of multiple PSAPs. Additionally, wireless calls do not always connect to the closest cell site, especially if the closest cell site is busy handling other calls. Thus, the PSAP closest to the cell site may not be the cell site closest to the caller.

B. Operational Impact on PSAPs

PSAPs today face many challenges in processing wireless E9-1-1 calls. Most wireless users do not realize that emergency personnel have very little, if any, information about their location. The dispatcher on the other end needs to obtain information and communicate calmly to the caller that their call is being processed as quickly and efficiently as possible. One PSAP administrator in the trial area summarized this best by saying: "When you dial 9-1-1 you expect the other person on the phone to know where you are. We have to have the ability to quickly locate the caller and route them to the appropriate PSAP."

Over the course of the trial, OETS met regularly with PSAPs and interviewed E9-1-1 directors and public safety telecommunicators about the wireless location system and its impact on their ability to respond to calls. County 9-1-1 directors reported frequently to OETS about specific situations where the use of the technology further facilitated their operations. The reaction was extremely positive, with the consensus from the PSAPs that the wireless location system greatly improved their ability to respond to emergencies in a timely, efficient manner. As one dispatcher said: "This system takes the *search* out of search and rescue." There were several areas in which the trial demonstrated the positive effects of using the technology:

1. Location Accuracy

Public safety telecommunicators reported that the location technology accurately reported locations of wireless callers during the full period of the trial. In no case did a response unit report being dispatched to an incorrect location.

2. Routine Nature of Location System

In interviews with PSAP directors and public safety telecommunicators, it was evident that this technology became a routine part of handling 9-1-1 calls. Rather than an occasional high-profile event, life-saving assists occurred every day. Harrowing, drawn out searches like the famous South Dakota example were avoided because locations were immediately provided, and response times were reduced.

For example, in one incident, a 69 year old woman from out-of-state was visiting relatives late one night. She lost complete power in her car because of a broken alternator. Unable to get out of the car because of recessed power locks, she dialed 9-1-1 to summon help. Because it was late at night and she was stuck in a rural area, she was unable to identify any landmarks and she misidentified her exact location. The dispatcher was able to determine an accurate location because of the TruePosition location system, and a State Trooper was dispatched to the scene and relatives were called to help. The situation was fully resolved in less than 15 minutes.

In another incident during the test period, a wireless E9-1-1 call was received reporting a motor vehicle accident on "Jacksonville Road". The caller could not tell the dispatcher which of four possible Jacksonville Roads in the general area was the right one. The dispatcher was able to see the exact location on the PSAP terminal and send an emergency unit to the scene.

Stories like these became routine occurrences during the system trial. PSAP directors also explained that while adjacent areas were forced to deal with threatening phone calls and bomb threats, no such incidents were reported in the trial area during the test from wireless calls.

3. Efficiency of PSAPs

The public safety telecommunicators reported that the time of response to a wireless calls was significantly reduced. Previously, public safety telecommunicators responding to a wireless caller would need to spend several minutes asking questions about the area in order to determine where the call was coming from and attempt to narrow down the location before sending units to respond. During the trial, public safety telecommunicators were able to access the mapping section and find the caller within seconds. For example, the Camden County Coordinator stated: "It is quite evident that because of the triangulation of this cellular 9-1-1 call, the investigation time was greatly reduced. Without it, who knows how long it would have taken to find this MVA [motor vehicle accident]." PSAPs estimate that using the technology, they were typically able to respond and process the average wireless E9-1-1 call under a minute.

Public safety telecommunicators reported that the system helped them manage incoming calls to the PSAPs and coordinate better with informed outgoing requests for assistance to emergency response units. Throughout the State, administrators and public safety telecommunicators often report being overwhelmed with wireless calls, but impeded in their ability to dispatch help properly. The opposite reaction was had by users of this new wireless location system. A participant said: "The new system has not been a problem for the dispatcher. What it has done is raise the comfort level of everyone." Another stated: "The trial made our 9-1-1 center much more efficient, increased the individual capacity of each telecommunicator, and allowed us to serve greater numbers of callers with the same resources."

Public safety telecommunicators also reported that the system assisted them in weeding out duplicative calls from the same location to report traffic accidents, disabled vehicles, etc. Prior to the trial, public safety telecommunicators were often frustrated because they would receive multiple calls with various location descriptions from the wireless callers. Because they did not have the location of the call, they needed to answer

and process each one of them. Because they could not be sure where the emergency was located, they often dispatched multiple units to respond to multiple locations. However, a PSAP official who participated in the trial said: "This technology is helping the well being of every dispatcher. With it they know where the call is coming from so that multiple calls can be removed from the system quickly and appropriate help can be directed to the emergency. Without the technology, we have to figure out if callers are referring to the same accident. People will call with, 'I just passed an accident on Route 55, but don't have any exact location'."

Although the increase in usage of wireless telephones means an increase of E9-1-1 calls for PSAPs, the ability to determine caller's locations in very short periods of time saves PSAPs time and allocates the use of public safety telecommunicators and emergency resources in a more efficient manner. Without wireless location technology, the burden on PSAPs will continue to increase with no means of effectively managing and handling it. One County Coordinator stated: "The percentage of calls from wireless users is now approaching 50%, and has increased steadily even over the last year. With our resources, if we don't implement a system like this, I don't see how we'll be able to respond quickly enough to the calls."

The trial also highlighted the challenges and impact of E9-1-1 in a non-urban setting. A dispatcher said: "In rural areas there are not a lot of road signs and in some areas the nearest intersection may be 2-3 miles away. You can walk blocks and still have no idea where you are." The incident where the woman was stuck in her car at night on a country road is a perfect example. Wireless E9-1-1 may have its greatest impact for PSAPs to locate callers not helped by the seeing the nearest exit sign on an interstate or closest mile marker on a highway. Trial participants also report additional uses for a wireless location system. "When this technology is fully operational it will also have a big impact on boaters on the Delaware River and the Delaware Bay. When a boater breaks down, they have a great deal of difficulty figuring out where they are. When you have a mix between commercial vessels and recreational boaters on the water, it's important to find distressed boaters."

4. Integrating Location Technology System

The PSAPs involved in the trial reported no difficulties in using the new system and indicated that there was little or no transition time once the trial commenced in January. The new system was easy to use and user friendly. The same PSAP terminals and mapping computers for wireline E9-1-1 calls were used for wireless E9-1-1 calls. One dispatcher said, "Everything I needed to know was right there on the screen in front of me within seconds - the caller's number and a map showing the caller's location. Instead of spending time asking a lot of questions, I was able to assure the caller I knew where he was and that a unit was on its way to help him."

During the trial, system integration posed little problems for operators and far outweighed the resources needed to use the system. Some of this success is due to the fact that New Jersey has a coordinated statewide 9-1-1 network, which many states do not. However, the overall success of the trial was only made possible with the total dedication of all of the participants.

C. Operational Impact on New Jersey's Existing Wireline 9-1-1 Network

Aside from the usual short term errors encountered in any first time trial, the other components of the trial functioned very well. For example, when OETS first approached Bell Atlantic-New Jersey about participating in the project, the idea was greeted with mixed reactions: "Being out front is both challenging and rewarding, as long as you are successful. We were, after all, talking about running an experimental process through a wireline network that was handling over thirteen thousand live 9-1-1 calls every day." As the scope of the trial became apparent, questions were raised - most of which showed concern:

- What effect would this trial have on the rest of the network?

- Would the new software changes inhibit call processing in the 9-1-1 tandems?

- Could signals received over the new location/selective router system interface corrupt the 9-1-1 tandem's database, or bring the tandem down completely?

- What if the location system was hopelessly inaccurate, and if so, who would be held responsible and have to perform damage control?

- What if the location system was a lemon and what would it cost to dedicate the resources to keep it afloat for the trial period?

During the initial round of planning meetings, it became obvious to all of the participants that this would be a well planned and organized venture, run by people who knew their business and were dedicated to the success of the team. Bell Atlantic-New Jersey and Comcast Cellular installed Feature Group D signaling between the Comcast's Mobile Switching Center (MSC) and Rockwell's SCX 9-1-1 Tandem Switch. This required new interface software in the Rockwell switch and programming in the MSC.

Second, a new data link interface was created to accept routing and location information for delivery to the PSAP. These were new untried interfaces on a live 9-1-1 tandem. If the location system, selective router system or PSAP terminals had to be taken off line because new features were not working properly, these changes could be done without affecting 9-1-1 service. This could not be said for the 9-1-1 switch. It had to continue functioning no matter what else happened.

Perhaps what is most significant, is what did not happen. While the concerns stated above were appropriate, the wireless location system integration went extraordinarily well. The new software and interfaces functioned as expected, thanks to the technical support from Rockwell and Bell Atlantic, who loaded and constantly monitored the functioning of the software. Routing and location data were passed to and through the 9-1-1 tandem as designed. There were no "side effects" that inhibited normal 9-1-1 call processing in the tandem. There were no cases of errant transmissions corrupting the tandem's database. In fact, the system worked so well that the initial concerns eventually evaporated, and it became an accepted part of the overall network. As one of the participating entities said: "It can be said that it became routine, which is about as good as it gets."

All of the participants were proud to participate in the New Jersey wireless project and would like to see the system expanded and made permanent. They continue to remain dedicated to improving the quality of life through enhanced 9-1-1 and the intelligent use of technology. Accordingly, the trial is continuing with several changes being made to the system to improve its location ability.

V. Location System Testing and Accuracy

A. Testing Procedures

1. Testing Methodology

The accuracy of the wireless location system was measured through extensive testing. Before the initiation of the trial, OETS had planned to measure the accuracy of the system by requesting PSAP operators and public safety telecommunicators to use an electronic map terminal to compare a caller's TruePosition-calculated location with the caller's "actual" location as reported verbally during the call. However, two problems were encountered with this planned testing methodology. During emergencies, public safety telecommunicators are heavily engaged in responding to the emergency (i.e. gathering critical details, dispatching and routing ambulances, coordinating resources) and frequently do not have the time to record trial information before the next emergency call arrives. Second, people involved in an emergency have difficulty explaining their exact location in sufficient detail to make a meaningful estimate, which is, after all, the reason we need the new technology in the first place. A typical verbal estimate might be "a quarter mile past the Route 30 overpass," which is not sufficient to verify a 410-foot accuracy requirement.

Therefore, all participants in the trial adopted a testing approach that involved organized drive testing of the system. The location system was configured such that it would locate both wireless E9-1-1 callers and phones identified as test phones. Various test points along the New Jersey Turnpike, I-295, as well as off-highway test points were accurately surveyed using Differential Global Positioning System (D-GPS) receivers. In excess of 100 separate test points were surveyed in this manner. The drive testing was accomplished by sending drive test volunteers in vehicles to the test points, where the volunteers would place test calls. Between 1 and 100 test calls might be placed at various test points during each day of drive testing, depending on the test objective for the day. The system recorded the calculated locations of the test calls into a database for analysis. In addition to the test calls placed during drive testing, the TruePosition development team placed test phones at fixed sites throughout the trial area. These phones were automatically located approximately every 10 to 15 minutes as a continuous measure of the performance of the location system.

Additional testing was conducted by other parties including Comcast, OETS staff, the E9-1-1 Public Safety Agencies of Salem, Gloucester, and Camden counties, and a large, independent telecommunications company, all of which reported similar results.

OETS believes that the drive testing described above is representative of the performance of a location system during actual emergency calls. The participants monitored the profile of actual emergency calls, and concentrated testing in those areas where the most number of E9-1-1 calls were received.

2. Numbers of Test Calls

The following number of test calls were placed during the trial period:

65, 445 test calls were placed by TruePosition from test phones at a number of fixed places throughout the trial area.

11,064 test calls were placed by the TruePosition development team during drive tests of various portions of the coverage area.

5,247 test calls were placed by the other parties, such as Comcast, personnel from Salem, Gloucester, and Camden counties, and a major independent telecommunications company.

Over 81,700 test calls were placed, of which over 16,300 were from drive testing. This represents extensive dedicated testing when compared to the 3,505 actual E9-1-1 calls received during the trial period in the coverage area. Examples of test calls are shown below:

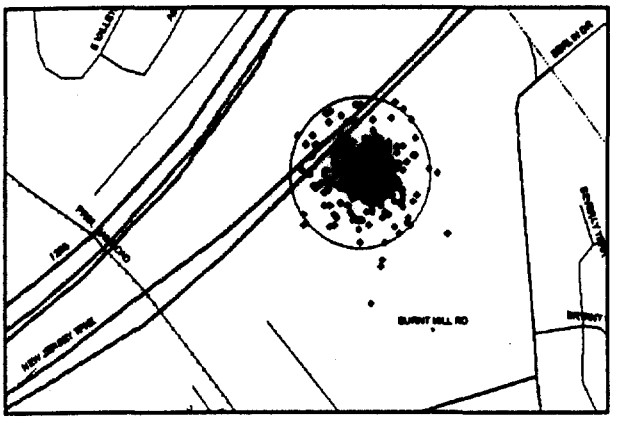

Figure 11 – Example of Multiple Calls From Test Phone At Fixed Place

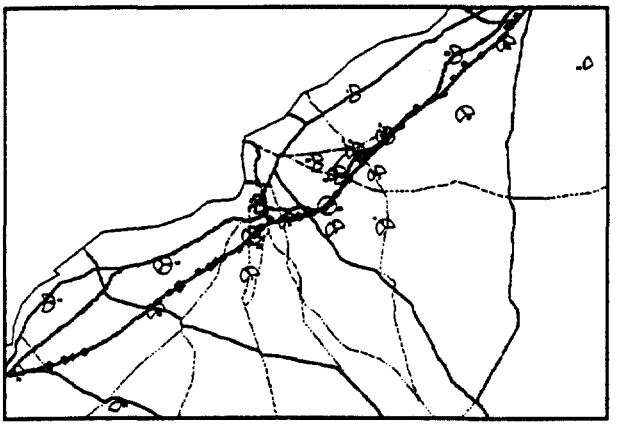

Figure 12 – Example of Drive Test by 9-1-1 Personnel

In each of the two examples above, each test call is represented on the plot by a single diamond, or point. Multiple diamonds clustered tightly together means that multiple test calls were made, and similar location estimates were made by the location system. In Figure 11, the circle drawn in the plot has a radius of 125 meters (410 feet) around the actual location of the fixed phone. In figure 12, personnel from Salem, Gloucester, and Camden County PSAPs drove the entire 50 mile section of the New Jersey Turnpike, placing test calls at various points on the route. On this particular drive test, the location errors ranged from 50 to 700 feet. The aggregate data presented later is a composite of many tests such as the ones shown in the above examples.

B. Accuracy of Location Measurement

1. Summary

OETS concludes from this test experience that the TDOA location system tested is capable of meeting the FCC Report and Order Phase II requirement of accuracy to at least 410 feet for 67% of wireless 9-1-1 calls. OETS also concludes that this technology was highly valuable to the PSAP public safety telecommunicators and to the calling public because of the reduction in response time when a wireless caller could not identify his/her own location.

OETS and the trial participants also learned about changes that would be required in moving from the current trial system design to a future fully operational location system. For example, the TDOA location technology tested exceeded the FCC location accuracy requirement of 410 feet, 67% at several test points, but did not meet the accuracy requirement at all test points. The reasons for the these differences in performance at different test points seems largely related to the manner in which the location system receivers were installed in the field, also known as the system design. The location system receivers were installed at 55% of the cell sites in the trial, with the distribution of the receivers varying widely over four separate coverage zones. Additionally, the receivers were deployed in a manner more conducive to achieving location performance parallel to the New Jersey Turnpike. By changing the system design for a fully operational system, including covering a greater percentage of cell sites and arranging the receivers in a more circular or square pattern over a wider area, OETS is highly confident that the FCC location accuracy requirements can be met at all test points in the future.

The accuracy results can be summarized as follows:

- The technology used in the trial solved the real world problems PSAP operators are having with the explosion of wireless E9-1-1 calls. In anecdotal feedback, the live wireless E9-1-1 calls produced no complaints from public safety telecommunicators of incorrect locations.

- The results of the program testing, including the improvements made during the test period, give OETS a high degree of confidence that technology exists today to create operational wireless E9-1-1 location systems meeting or exceeding the FCC's Phase II accuracy requirement. In the better coverage areas (high enough ratio of location receivers to cell sites, high ratio of receivers per mile, and better receiver placement), the location system met or exceeded the FCC's Phase II accuracy requirements. Operational systems need to have higher overall coverage than was used in this test (only 55% of the cell sites had receivers).

- The overall test *average* error declined from 1,400 feet during the preliminary operations in early January to 635 feet at the end of April due to significant engineering changes made by the TruePosition development team based on lessons learned during the testing. The lessons learned could not have been known prior to testing of a location system on such a wide scale (350 square miles). Unfortunately, the commitment to daily operate a full time, live wireless E9-1-1 system prevented certain system changes that would allow further accuracy improvements. These changes could have only been made by essentially terminating the test.

- Due to the long, narrow system design of the coverage pattern, parallel results (error measurements that run parallel to the New Jersey Turnpike and I-295) were more accurate than transverse results (error measurements that run perpendicular to the New Jersey Turnpike). This was of great practical value when locating vehicles on highways.

- o The technique used by TruePosition for synchronizing its receivers was not as stable as desired over many days, and over the length of the coverage area. The technique, known as external calibration, had been successfully used in smaller trial areas by TruePosition, but the technique did not scale as well as planned. TruePosition identified an improved synchronization technique during the initial trial period which will be intergrated into the system as the trial continues.

2. Operational Results

At the operational level, accuracy was reported to be excellent by the PSAPs. OETS received no reports or complaints of incorrect locations from public safety telecommunicators or their public safety clients. As discussed elsewhere in this report, PSAP operators were extremely pleased with the results.

3. Organized Testing Results

In organized testing, OETS observed that the performance of the location system both varied from test point to test point, and varied from day to day. The test point variability is generally related to the coverage of the location system relative to the coverage of the cellular system hosting the location system. That is, the cellular system covering the trial area currently uses 43 cell sites, while the trial location system used receivers at only 24 of those sites. This is a coverage ratio of only 55%. More importantly, the arrangement of the receivers in a long, narrow corridor distorted the accuracy performance, providing better performance parallel to the Turnpike and worse performance transverse to the Turnpike. Based on the lessons learned in this first-ever wide area location system trial, OETS and TruePosition now estimate that a normal deployment of receivers for a fully-operational system should be at 80% to 100% of cell sites.

The day to day variability was primarily related to the manner in which TruePosition synchronizes the receivers of a location system. The design goal of a TDOA location system is to maintain time synchronization between the receivers at all of the cell sites to within 30 nanoseconds (30 billionths of a second). TruePosition's confidence in its particular technique, known as external calibration, was based upon previous test results in several smaller location system technology trials. Unfortunately, the technique did not scale as well as hoped in moving from smaller trial areas, 20 square miles or less, to the larger New Jersey trial area of 350 square miles. On some days, and at some times, the synchronization error ranged as high as a few hundred nanoseconds. This directly contributed several hundred feet of error to the location estimates at some test points. Midway through the trial period, TruePosition identified an improved synchronization method as stated above and will be incorporated as the trial continues.

a. Operational Zones

One of the purposes of the test was to determine the optimum coverage pattern, or system design, required to achieve a high degree of accurate location readings. In other words, what number and placement of TruePosition receivers on a cellular system would deliver the best results at the most number of test points.

OETS and TruePosition share the opinion that a fully operational system would meet the FCC standard because it would correct for both the low (55%) use of location receivers, and the parallel placement bias (because operational systems would be designed for full area coverage, not focused on a narrow corridor of two parallel highways).

The New Jersey Turnpike / I-295 Corridor was divided into 4 separate zones as shown in the map which follows (Figure 13). These zones roughly correspond to the 4 counties involved in the trial, but also represent different coverage ratios of the location system relative to the host cellular system, different coverage ratios per

mile of highway, and different geometric placement patterns. The same type of analyses performed for individual test points was also performed for all test points that occurred within the zone. As demonstrated by the map, the coverage pattern overall was a long narrow strip, biased towards parallel coverage of the major highways, instead of being a complete grid matching the full cellular coverage of southern New Jersey. It turned out that this early system design decision was fundamental to a large percentage of the error margins observed. In reviewing the placement of the TruePosition location receivers, it is clear that the sources (angles) for transverse triangulation (at various angles to the two main highways) were far more limited than the sources of measurement parallel to the highways.

The TDOA system works most accurately when it can measure signals from a variety of location receivers surrounding a transmitting telephone: ideally like an eight-pointed star. In far too many instances, there were only two or three "points of a star" close enough to receive signals, and these were not evenly spaced around the telephone on the points of a compass.

The coverage zones are shown in the following diagram:

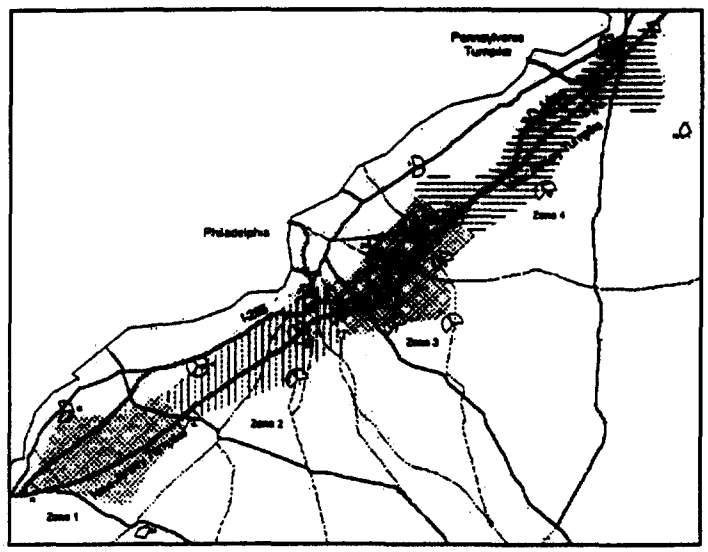

Figure 13 – Map of Four Test Zones

The first zone, at the southern end of the trial area (Salem County), is 10.8 miles long and is covered by location system receivers at four of the six cell sites. In this zone, location accuracy tended to be better in the center sections of the zone and test points closer to the corners of the zones performed less well. The first zone is rural in character.

The second zone, covering predominantly Gloucester County, is 8.1 miles long and has receivers on four of eight cell sites. Additionally, the configuration of receivers is more limited in the transverse direction (across the turnpike) than parallel to the turnpike. The second zone includes an area of reduced cellular coverage, and location performance of test points in that area was also reduced. This zone is suburban in character.

The third zone, corresponding to Camden County, is 10.6 miles long and has receivers on eight of eighteen cell sites. The relatively dense receiver configuration produced the most accurate results. This zone is also the most heavily populated, with a high number of multi-story apartment and office buildings. Besides turnpike and I-295 testing, many test points on residential streets were included in this area.